

## Purchasing Power Parity and Exchange Rate in Nigeria: A Regime Switching Approach

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*This study basically extends the work of Obaseki (1998) by including an additional variable to capture the impact of changes in exchange rate regime. The paper undertakes an empirical examination of the long-run co-movement in naira exchange rate and relative price levels of Nigeria and USA. The impact of the policy swap from a system of exchange rate control to a market based system (captured by a dummy variable) is investigated using an error correction model. The outcome reveals the applicability of the PPP using Nigerian data. From the analysis, the prevailing nominal exchange rate during the period closely approximates that suggested by PPP. Furthermore, the change in exchange rate regime had a considerable effect in re-aligning the naira exchange rate. The implication of this is that continued floating of the naira will in the long-run, bring its exchange rate to equilibrium.*

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### I. Introduction

Contemporary economies are largely characterized by inter-border trade. This is made possible by differences in the factor endowment of each economy as postulated by the popular theories of comparative and absolute advantages. The prices of goods exchanged across international borders are key determinants of the volume of trade amongst countries. The law of comparative advantage implies that countries will produce more of those commodities whose opportunity costs of production are lowest in their domestic economy. The consequence of this is that goods will be cheaper when produced by a country that has comparative advantage in the production of such goods.

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<sup>2</sup> The law of comparative advantage is better understood with the Heckscher-Ohlin theorem. It says “a country has comparative advantage in those goods whose production is intensive in the factors with which that country is

In reality, however, more than one country can produce a particular (or similar) commodity(ies). The prices of these goods are expected to be related across geographically disparate markets and are comparable using an exchange rate, which is the price of a currency in terms of another currency. The tendency for similar goods to sell for similar prices globally provides a link between prices and exchange rate. The exchange rate between two countries that would equate the two relevant national price levels if expressed in a common currency at that rate is the Purchasing Power Parity (PPP) (Sarno and Taylor, 2002). Put simply, the PPP theory of exchange rate states that the exchange rate between any two currencies tends to reflect their relative purchasing power (Ojameruaye, 1990). Thus, changes in relative price levels in the relevant economies portend serious implications for the stability of the exchange rate.

In the case of Nigeria, large changes characterize the general price level and the exchange rate, thus making the naira exchange rate seem misaligned. An earlier investigation of the applicability of the PPP by Obaseki (1998) equivocally discarded the PPP in Nigeria as irrelevant. Hence the question, *is the PPP really inapplicable to Nigeria's exchange rate? Is there a long run relationship between the prevailing naira exchange rate and that suggested by the PPP? Have the different exchange rate regimes had any impact in re-aligning the naira exchange rate? Is the regime switch in Nigeria important in validating the PPP theorem?* This research intends to answer these questions.

According to MacDonald (1995) since the post-Bretton Woods period there has been considerable evidence supportive of a long-run relationship between relative prices and exchange rate. This suggests that exchange rate

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*relatively endowed". See also Steven Husted and Michael Melvin, International Economics, HarperCollins College Publishers, 1993.*

<sup>1</sup> *Though he confirmed the relevance of the PPP if applied on the parallel market rate, he nonetheless found it inapplicable when the official exchange rate is used.*

pegging may invalidate PPP theorem and that changes in exchange rate regime are important in determining a long run relationship between relative prices and the exchange rate.

There is, therefore, the need to empirically examine the relationship among prices and exchange rate in Nigeria after including the regime switch factor. Hence, this study investigates the applicability of the PPP to the naira exchange rate while taking account of the changes in exchange rate regime.

The paper is divided into six sections. Following the introduction is section II, which provides the background to the study and trend analysis. Section III is the literature review while the analytical framework and model specification are contained in section IV. Empirical results are presented and analysed in section V while the paper is concluded in section VI, which also contains the recommendations.

## II. Background and Trend Analysis

The determinants of exchange rate in any country are necessarily dependent on the exchange rate policy of that country. In Nigeria, exchange rate policy has gradually moved from a regime of fixity to that of flexibility between 1960 and 2004. Before 1986, exchange rate of the naira was purely administratively determined or fixed. This was very convenient, as fixing the exchange rate provided a more effective mechanism for the maintenance of balance of payments viability and controlling inflation in the Nigerian economy (Nnanna, 2002)

Between 1960 and 1972 the exchange rate was fixed and pegged to the British pound sterling. The exchange rate, which stood at N0.7143 per US dollar, maintained a parity with the British pound sterling for a larger part of that period. The general price level during this period was relatively stable

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<sup>1</sup> *Domestic and foreign price indexes.*

hovering around 8.2 (1985=100) between 1960 and 1969. With the Devaluation of the pound sterling in 1967, the monetary authorities introduced the US dollar as one of the reference currencies in determining the value of the naira. This development coupled with the post-war reconstruction saw the inflation rate in Nigeria rising from 1.5% in 1968 to 10%, 13.9% and 16% in 1969, 1970 and 1971, respectively.

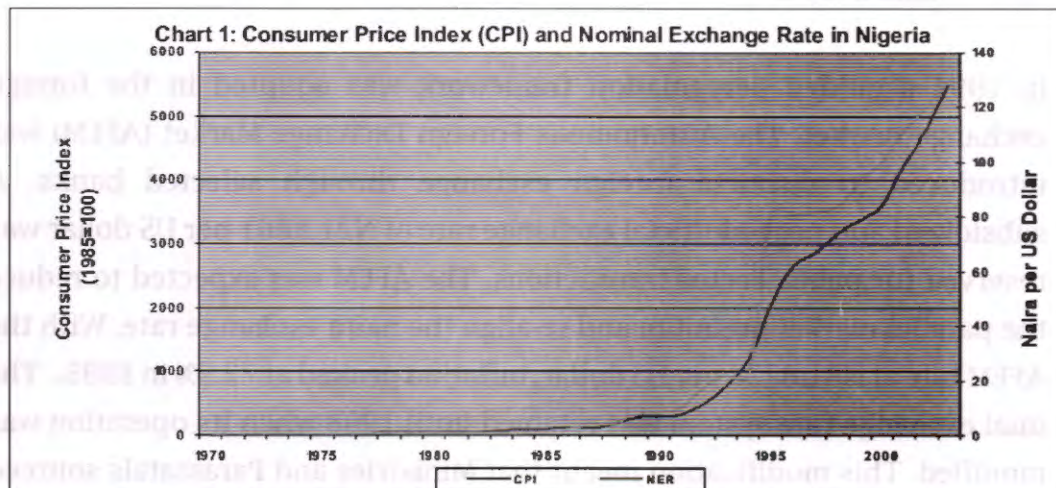
Following the international financial crisis of the early 1970s, which led to the devaluation of the US dollar, Nigeria abandoned the dollar peg and once again kept faith with the pound until 1973, when she reverted to the US dollar peg (Nnanna, 2002). The overvaluation of the naira at the time made the authorities to shift to a regime of managed float from 1973 to 1978. This period coincided with the oil-boom era. Prices rose and the rate of inflation averaged about 18% annually with a peak of 33.9% in 1975. The continued overvaluation of the naira and persistent depletion of the reserves, due to excessive importation and rapid outflow of foreign exchange, culminated into a change in exchange rate management technique. From 1978, the CBN adopted a basket of currencies' approach as a guide in determining the value of the naira exchange rate and, hence, the direction of its movement.

The deterioration of the external reserves position and a highly overvalued naira led to a major policy switch in 1986. The fixed exchange rate system was discarded and replaced with a flexible exchange rate mechanism. A dual exchange system was maintained at that time. While the first-tier was a carryover from the fixed exchange rate system, and was meant to accommodate transitional transactions, the Second-tier Foreign Exchange Market (SFEM), was left to the influence of market forces. As a result, the naira exchange rate, for the first time experienced a sharp depreciation

<sup>1</sup> See Obaseki P. J. (2001); "Issues in Exchange Rate Policy Design and Management", CBN Economic and Financial Review, Vol. 39, No 2.

<sup>2</sup> The exchange rate maintained at the first-tier market was less depreciated.

between 1985 and 1986, falling by 55.77% at the SFEM. The rate of inflation, however, rose marginally from 4.7% in 1985 to 5.4% in 1986. The naira continued to depreciate, even as the first and second tier markets were merged in 1987 into a single Foreign Exchange Market (FEM). By the end of 1989, the naira exchanging at N7.3916 per US dollar, had depreciated by 38.62% from its level in the preceding year. With the continued depreciation of the naira, the general price level displayed an upward movement growing by 10.2%, 56.0% and 50.5% in 1987, 1988 and 1989, respectively.



The Inter-bank Foreign Exchange Market (IFEM) was created in 1989 to correct for the destabilizing speculative tendencies of the FEM (Obaseki, 2001). The naira continued to lose value under market forces as the CBN switched the rate determination under the Dutch Auction System (DAS) between pure DAS, marginal rate pricing, highest and lowest bids, etc. The premium between the parallel market and official rate fluctuated during this period, though the monetary authorities tried to keep it as narrow as possible.

Between 1989 and 1994 several attempts were made to stabilize the exchange rate. The persistent instability in the foreign exchange market led



to the pegging of the naira officially at N21.8861 per US dollar in 1994. The parallel market was declared illegal. Interest rate was also fixed during that period. According to Obaseki (2001), the rationale for this was to reduce the cost of production and moderate inflation. This was, however, not justified, as inflation rate only responded slightly, falling from 57.2% in 1993 to 57.0% at the end of 1994. Under the 1994 regime of re-regulation, the CBN supplied foreign exchange to end-users. Given that the supply of foreign exchange was low, demand was met only on a *pro rata* basis. The re-regulation caused the parallel market premium to widen while the stability of the exchange rate remained elusive.

In 1995 a guided deregulation framework was adopted in the foreign exchange market. The Autonomous Foreign Exchange Market (AFEM) was introduced to disburse foreign exchange through selected banks. A subsidized and pegged official exchange rate of N21.8861 per US dollar was reserved for public sector transactions. The AFEM was expected to reduce the parallel market premium and re-align the naira exchange rate. With the AFEM rate at N81.0228 per US dollar, inflation peaked at 72.9% in 1995. The dual exchange rate system was retained until 1998 when its operation was modified. This modification meant that Ministries and Parastatals sourced their foreign exchange needs from the AFEM, as the pegged official rate was applicable to only a small proportion of foreign exchange transactions; specifically for external debt servicing.

Although, some macroeconomic aggregates showed improvement in 1995 *vis-à-vis* their performance in 1994, inflation rate continued to trend upward. The naira exchange rate maintained an average of N84.0150 per US dollar between 1995 and 1998. The stability of the naira notwithstanding, the PPP calculated as N88 per US dollar for this same period suggests an overvaluation (Obaseki, 2001). The Dual exchange rate was totally abolished in 1999 and IFEM re-introduced. This brought about a more stable naira

exchange rate and the tapering of the parallel market premium. Correspondingly, inflation rate during that period took a downturn, falling from 29.3% in 1996 to 10.0% in 1998 and 6.9% in 2000. The DAS system of foreign exchange rate management was introduced in July 2002 to correct some of the shortcomings of the IFEM and ensure exchange rate stability.

**Table 1:**  
**Exchange Rates and General Price Levels (Nigeria and USA). (1985=100)**

Consumer Price IndexIn			flation		Exchange Rate 1/		Growth Rate 2/	
Year	USA	Nigeria	USA	Nigeria	OFE	MARKET	OFE	MARKET
1970	36.07	10.80	5.70	13.90	0.7143	-	-	-
1971	37.66	12.60	4.40	16.00	0.6955	-	-2.70	-
1972	38.87	13.00	3.20	3.40	0.6579	-	-5.72	-
1973	41.28	13.60	6.20	4.60	0.6579	-	0.00	-
1974	45.82	15.50	11.00	13.50	0.6299	-	-4.45	-
1975	49.98	20.70	9.10	33.90	0.6159	-	-2.27	-
1976	52.88	25.10	5.80	21.10	0.6265	-	1.69	-
1977	56.32	30.40	6.50	21.50	0.6466	-	3.11	-
1978	60.60	34.50	7.60	13.30	0.6060	-	-6.70	-
1979	67.45	38.50	11.30	11.60	0.5957	-	-1.73	-
1980	76.56	42.40	13.50	10.00	0.5464	-	-9.02	-
1981	84.44	51.40	10.30	21.40	0.6100	-	10.43	-
1982	89.68	55.10	6.20	7.20	0.6729	-	9.35	-
1983	92.55	67.90	3.20	23.20	0.7241	-	7.07	-
1984	96.53	95.60	4.30	40.70	0.7649	-	5.33	-
1985	100.00	100.00	3.60	4.70	0.8938	-	14.42	-
1986	101.90	105.40	1.90	5.40	2.0206	-	55.77	-
1987	105.57	116.20	3.60	10.20	4.0179	-	49.71	-
1988	109.90	181.20	4.10	56.00	4.5367	-	11.44	-
1989	115.17	272.70	4.80	50.50	7.3916	-	38.62	-
1990	121.39	293.20	5.40	7.50	8.0378	-	8.04	-
1991	126.49	330.40	4.20	12.70	9.9095	-	18.89	-
1992	130.28	478.40	3.00	44.80	17.2984	-	42.71	-
1993	134.19	751.90	3.00	57.20	22.3268	-	22.52	-
1994	137.68	1180.70	2.60	57.00	21.8861	-	-2.01	-
1995	141.50	2040.90	2.80	72.90	21.8861	81.0228	0.00	-
1996	145.61	2638.10	2.90	29.30	21.8861	81.2528	0.00	0.28
1997	149.00	2863.20	2.33	8.50	21.8861	81.6494	0.00	0.49
1998	151.41	3149.20	1.61	10.00	21.8860	83.8072	0.00	2.57
1999	154.66	3357.60	2.15	6.60	-	92.3428	-	9.24
2000	159.90	3590.50	3.39	6.90	-	100.1194	-	7.77
2001	164.43	4267.98	2.83	18.87	-	111.5166	-	10.22
2002	166.97	4817.80	1.55	12.88	-	120.4700	-	7.43
2003	170.79	5493.30	2.29	14.02	-	129.2230	-	6.77

Source: Central Bank of Nigeria, Statistical Bulletin. Various issues.

International Monetary Fund, International Financial Statistics. Various issues.

Note: 1/ OFE = Official Exchange Rate; MARKET = Autonomous/Inter-bank Foreign Exchange Market & the Dutch Auction System

2/ Negative growth rate indicates an appreciation.



### III. Review of Literature

#### Conceptual Issues

The PPP is based on the law of one price (LOP), which holds that prices of the same commodities would equalize across national borders with differences accounted for by transport cost, information asymmetry (Obaseki, 1998), tariffs and other trade barriers. In any country, changes in the prices of different commodities are not constant over time. Hence, while the LOP could hold for individual goods, the PPP could be violated for a price index. Since the component of the goods basket usually differs across countries, price indexes are not comparable internationally. In computing a price index, weights assigned to the various commodities in the basket vary significantly among countries. In practice, therefore, the PPP hardly equates the exchange rate. Besides, empirical works have shown that macroeconomic variables, such as the relative interest rate and relative net foreign assets positions, as well as relative productivity levels in tradables and non-tradables sectors (the so called "Balassa-Samuelson effect") are also important in explaining deviations from PPP (MacDonald and Ricci, 2002). A persistent deviation between the rate suggested by the PPP and the prevailing exchange rate has serious macroeconomic consequences.

Scores of theoretical and empirical literature exists on the relationship between prices and exchange rate, and on the purchasing power parity. While some of these refuted the presence of any relevant relationship between exchange rate and price, the PPP was indeed upheld by several of these studies. As Obaseki (1998) noted, overwhelming evidence exists to fault the efficacy of the PPP in the short-run, while its long-run relevance has been proven only in isolated circumstances.

Ojameruaye (1990) attempted to compute the PPP of the naira relative to the US dollar and the Special Drawing Rights (SDR) and assess the extent of

<sup>1</sup> Law of one price would not apply to differentiated products or to products that are not traded internationally.

overvaluation/undervaluation of the naira during the period, 1970-1988. In his study, he preferred the use of consumer price index though he recognised its shortcomings. Examining the inflation differentials between Nigeria and her major trading partners, he opined that the use of the PPP to gauge the extent of overvaluation/undervaluation of the naira has some “residual validity”.

Using the consumer price index (CPI) for Nigeria and the United States, Obaseki (1998) adjudged the PPP irrelevant in Nigeria when applied on the official exchange rate, but he went ahead to establish a long-run relationship using the parallel market rate. In his study, he used the exchange rates as his dependent variable. Obaseki was of the opinion that the PPP will break down in a regime of fixed exchange rate, as in the case of Nigeria. This seems to corroborate the statement of Bleaney (2001) that in a floating exchange rate regime prices tend to change more often. Bleaney noted further that changes in the price level are more persistent under floating exchange rates than under pegged rates. A co-movement in general price level and exchange rate, therefore, subsists.

An empirical study of South Africa by Jonsson (2001) indicated that there exists a long-run relationship among domestic prices, foreign prices and nominal exchange rate. Using quarterly data between 1970:1 and 1998:2, Jonsson defined domestic price index as headline consumer price index after excluding the highly volatile food prices and the cost of housing. He calculated the nominal exchange rate and foreign price index in effective terms using figures from four countries: USA, Britain, Germany and Japan by allocating weights to each of the countries. He preferred the use of domestic prices as his left-hand-side variable.<sup>1</sup>

<sup>1</sup> Otherwise referred to as dependent variable.

<sup>2</sup> Pass-through is a variant of the Law of one price. It tries to determine the extent of a shock in the exchange rate that is passed on in the prices of internationally-traded goods.

Takagi and Yoshida (2001) investigated the response of tradable goods prices in Japan to exchange rate movement with respect to selected East Asian and industrial country trading partners. Estimating a pass-through co-efficient,<sup>2</sup> they opined that prices of tradable goods generally do not change proportionately with a change in the exchange rate. The authors postulated that in a world of imperfect competition, the same commodities may be sold in different markets at different prices.

In his paper, MacDonald (1995) surveyed recent empirical literature on the long-run exchange rate modelling. Essentially, he reviewed the voluminous literature that tests for a unit root in real exchange rates and the closely related work on testing for a unit root in the residual from a regression of the nominal exchange rate on relative prices. He stated that the literature has had something of a symbiotic relationship with recent developments in the time-series literature and, in particular, the literature on co-integration. He argued that the balance of evidence is supportive of the existence of some form of long-run exchange rate relationship. The form of this relationship, he discovered, does not conform exactly with a traditional representation of the long-run exchange rate due to measurement errors, traded/non-traded biases, econometric method related biases, and inter-border capital movements.

In another exhaustive review of existing literature, Sarno and Taylor (2002) noted that econometric studies suggest the breakdown of the LOP for a very broad range of goods put together. Thus, showing that though the LOP may hold for a commodity, purchasing power parity may not for a group of products together. Sarno and Taylor (2002) argued further that problems may arise in deriving the PPP from the LOP owing to a yet to be determined appropriate price index in the analysis of the PPP.

The method of computing price indexes differs across countries. While some countries adopt an arithmetic method others may utilize a geometric method. The weight attached to different basket of goods also varies across countries. A major reason, therefore, for the violation of the PPP may be the price index adopted in a study. Many researchers have investigated the PPP using different price index. The most appropriate price index to use in the study of PPP is yet to be explicitly determined. For the purpose of this current study the composite consumer price index (domestic and foreign) is considered appropriate. *A priori* the PPP is expected to hold in Nigeria, since empirical evidence shows that it holds more in highly inflationary economies.

### Empirical Issues

Recent studies have shown that the standard procedure in testing for PPP includes tests for unit roots in the variables and test for co-integration. Obaseki (1998) in his study of PPP in Nigeria, discovered that the variables were integrated of order one,  $I(1)$ , while their linear combination was integrated of order zero,  $I(0)$ . Hence, a long-run relationship exists between exchange rate and prices. An error correction model (ECM), however, showed that there was no significant relationship between prices and the official exchange rate, though they were correctly signed. He, nonetheless, discovered that the parallel market rates exhibited a better result. He, therefore, concluded that the PPP is irrelevant when applied to the official exchange rate, but a long-run relationship exists between prices and parallel market rate in Nigeria.

Jonsson (2001) used a Vector Auto-regression model (VAR) in his study of South Africa. Including up to four lags using quarterly data, he noted that the estimated parameters for the nominal exchange rate and foreign prices have the expected signs and are fairly close to -1 and 1, thereby concluding that the "strict" PPP holds. He, therefore, concluded that exchange rate and prices move together in the long-run as predicted by economic theory. By

imposing exclusion restrictions, he tested the exogeneity property of the model and found, as expected, that foreign prices are clearly exogenous.

Testing for a pass-through effect, Takagi and Yoshida (2001) specified local demand conditions, marginal cost and exchange rate as factors that affect prices in the international market. Using a dynamic panel data model, they discovered that pass-through is greater for Japanese exports than for Japanese imports, which means that yen prices of Japanese imports do not fall (rise) very much when the yen appreciates (depreciates) while the response of Japanese export prices is considerable.

MacDonald and Ricci (2002) theoretically derived and empirically tested the implications of a “new” trade theory framework for the systematic movements in the real exchange rate. They focused on the effect of imperfect substitutability of tradables and on the importance of competitiveness, for which a proxy was constructed. Using a panel dynamic OLS estimation of nine bilateral US dollar real exchange rates, they derived long-run coefficients for relative productivity and competitiveness in the tradable and non-tradable sectors, controlling for standard macroeconomic variables. They discovered that implications of imperfect substitutability of tradables fit the data better than the standard neoclassical assumption of price equalisation. The new measure of competitiveness, they concluded, is significant in explaining deviations from PPP.

Sarno and Taylor (2002) in their work noted that the vast literature on PPP can be divided into six stages: the early empirical literature on PPP; test of the random walk hypothesis of real exchange rate; co-integration studies; long-span studies;

panel data studies; and finally, studies employing nonlinear econometric techniques. They stated that a major problem of the PPP is that of endogeneity of both nominal rate and domestic price levels. They further said that the choice of the variable to put on the left-hand-side is more-or-less arbitrary.

#### IV. Analytical Framework and Model Specification

The law of one price (LOP) holds that prices of similar products will remain the same across borders if expressed in the same currency *ceteris paribus*. In a compressed form it may be written as:

$$P_{it}^d = E_t P_{it}^f \quad i = 1, 2, \dots, N, \quad \dots\dots\dots 1$$

where  $P_{it}^d$  denotes the domestic price of commodity  $i$  at time  $t$ ,  $P_{it}^f$  is the foreign price of good  $i$  at time  $t$ , and  $E_t$  is the exchange rate expressed as units of domestic currency per foreign currency at time  $t$ .

If the LOP holds for every single traded commodity, then it will be logical to state that the summation of the different goods will be

$$\sum_{i=1}^N \alpha_i P_{it}^d = E_t \sum_{i=1}^N \beta_i P_{it}^f \quad \dots\dots\dots 2$$

where  $\alpha_i$  and  $\beta_i$  are weights attached to the  $i$ th good and  $\sum_{i=1}^N \alpha_i = \sum_{i=1}^N \beta_i = 1$  is satisfied. The terms  $\sum_{i=1}^N \alpha_i P_{it}^d$  and  $\sum_{i=1}^N \beta_i P_{it}^f$  are clearly price indexes in the two economies. Collapsing equations 1 and 2 we derive:

$$PI_t^d = E_t PI_t^f \quad \dots\dots\dots 3$$

where  $PI_t^d$  and  $PI_t^f$  are price indexes in the domestic and the foreign economies, respectively. Equation 3 can be re-arranged to give the absolute version of the purchasing power parity.

$$E_t = \frac{PI_t^d}{PI_t^f} \quad \dots\dots\dots 4$$

Equation 4 implies a non-linear relationship between exchange rate and prices. It defines exchange rate as the ratio of the domestic price level to the

<sup>1</sup> The basic argument why the LOP should hold is generally based on the assumption of frictionless goods arbitrage. Also the goods should necessarily be homogenous (or at least perfect substitutes).



price level in a foreign economy. The implication of equation 4, therefore, is that, an increase in domestic prices would result in an increase (a depreciation) in exchange rate, and *vice versa*, holding foreign prices constant, while a rise in the foreign price level would bring about a fall (an appreciation) in exchange rate if the domestic price level is held constant. The above relationship is clearer when equation 4 is linearised as:

$$e_t = p_t^d - p_t^f \dots\dots\dots 5$$

where the lower cases represent logarithm.

A semblance of the purchasing power parity (relative) is clearly obtainable from equation 5. The relative PPP states that changes in exchange rate is equivalent to inflation differential between the relevant economies under review. The direction of relationship between the prices under consideration and the exchange rate is explicitly shown in equation 5. A positive relationship is expected between the domestic price level and the exchange rate, while the reverse holds for the foreign price level.

Given that in the real world changes in exchange rate occur on a daily basis, while prices are less flexible, deviations in equations 3 and 4 are apparent in the short-run. In the long-run deviations are expected to have been corrected, such that

$$PPP_t = E_t = \frac{PI_t^d}{PI_t^f} \dots\dots\dots 6$$

Therefore, taking exchange rate as the dependent variable, the model to be investigated derived from equations 5 and 6, is specified as:

$$e_t = \phi_0 + \phi_1 p_t^d + \phi_2 p_t^f + \mu_t \dots\dots\dots 7$$

<sup>1</sup> Note that equation 5 is still the absolute PPP expressed in logarithmic form. It is only when converted to percentage changes that it becomes the relative PPP.

<sup>2</sup> Most foreign exchange markets in the world trade on a daily basis.

<sup>3</sup> Husted and Melvin (1993) described price as generally "sticky" and as such do not change daily, or frequently. See Steven Husted and Michael Melvin, *International Economics*, HarperCollins College Publishers, 1993.

Please note that the choice of exchange rate is arbitrary since domestic price level could equally serve the purpose.

where lower cases denote logarithm.  $\alpha_0$  and  $\epsilon_t$  are the constant term and the error term, respectively, while  $\beta_1$  and  $\beta_2$  are the parameters to be estimated for domestic and foreign prices, respectively. In the long-run model it is anticipated that both price levels exert significant influences on the exchange rate. *A priori*, it is expected that  $\beta_1$  should be a stationary process in order to ensure that deviations from equilibrium are corrected overtime. The *a priori* values for  $\beta_1$  and  $\beta_2$  are 1 and -1, respectively, for the PPP to hold in absolute version.

The study covers the period 1970 to 2003 and utilizes annual data obtained from various issues of the Central Bank of Nigeria (CBN) Statistical Bulletin and the International Financial Statistics of the International Monetary Fund. Use of annual data is favoured because the aim of the study is to analyse (and possibly determine) a long run relationship between the variables. The nominal exchange rate used for the empirical exercise is defined as the official rate from 1970–1994 and AFEM/DAS rate thereafter. The consumer price index is utilized as the price level since it is the most readily available in Nigeria. The choice of USA as the foreign economy is predicated on its position as Nigeria's largest trading partner and because the US Dollar is the intervention currency in the foreign exchange market in Nigeria. The author preferred the use of ordinary least squares method. A unit root test was performed to ascertain the stationarity of the variables using the Augmented Dickey-Fuller (ADF) approach. Failure of the variables to be trend stationary necessitated a test for co-integration to determine if their linear combination is stationary using the Engle-Granger method. All variables were converted to logarithmic form before estimation (as derived in the log-linearised equation 5 above).

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<sup>1</sup> The error term here is defined as a “white noise”, i.e. truly random.

<sup>2</sup> Exchange rate is defined as naira per US dollar

<sup>3</sup> About 50% of Nigeria's crude oil is exported to USA.

## V. Analysis of Result

Results of a preliminary estimation conducted using OLS on the structural model implied a superficially good result. A dummy variable was included in the model to capture the impact of exchange rate liberalisation. This is because the structural shift in exchange rate management is believed to impact on the exchange rate. The inclusion of the dummy variable, therefore, is to test for the direction and the significance of the impact of the regime shift on exchange rate determination. All the variables were significant at 1% and met their *a priori* expectation with respect to their signs. With an adjusted  $R^2$  of 0.99, an F-statistics that is significant at 1% and a Durbin-Watson statistic approximately at 2.0, the OLS result look as if it is robust.<sup>2</sup>

Table 2

Result of static regression

Dependent variable: Nominal exchange rate				
Sample: 1970 - 2003. 34 observations.				
Variable	Coefficient	Std. Error	T-statistics	Prob
Constant	5.156596	0.653970	7.885067	0.0000
CPI - Nigeria	1.268198	0.045605	27.80855	0.0000
CPI USA	-2.416466	0.186749	-12.93965	0.0000
Dummy	1.269927	0.122323	10.38175	0.0000

Adjusted $R^2$	Durbin-Watson	statF	statistics	Prob	(F-stat)
0.992781	1.976798		1513.683	0.0000	

<sup>1</sup> Basis of assigning value to the dummy variable is as follows: zero = the regime of fixed exchange rate; one = 'otherwise'.

<sup>2</sup> See table 2

<sup>3</sup> To allow for comparison of results in both scenarios.

<sup>4</sup> According to Gujarati D. M. (1995), only deterministic trends are included as regressors while stochastic trends are omitted. A trend is deterministic if and only if the given time series variable is devoid of a unit root; otherwise the trends is considered stochastic. See also Domodar N. Gujarati, *Basic Econometrics*, McGraw-Hills Book Co., 1995.

To ascertain the validity of this model, the variables were subjected to unit root tests using the standard Augmented Dickey-Fuller approach. First, the variables were tested for trend. The results, significant at 1% for all the variables indicated the existence of trend.<sup>3</sup> Though the variables were trended, the stationarity test was performed with and without trend. It should, however, be mentioned here that the trend variable omitted in the static regression presented in table 2 (above) because of its stochastic nature.<sup>4</sup>

<b>Table 3</b>				
<b>Results of Unit root test (see appendix for details)</b>				
<b>Augmented Dickey-Fuller</b>				
	Trend & Intercept	Intercept Only	Optimal Lag	Other of Integration
Nominal Exchange rate	-3.3123 (0.10)	-3.2508 (0.05)	1	(1)
CPI Nigeria	-3.7562 (0.05)	-3.8403 (0.05)	1	(1)
CPI USA	-5.1363 (0.01)	-2.6042 (0.10)	1	(1)

*Figures in parenthesis show level of significance.*

The variables were discovered to be integrated of order one; I(1). Optimal lags were derived using the Akaike Information Criterion and was found to be one for all the variables. Since the variables were not I(0), the Engel-Granger (EG) two-step co-integration test was performed on the residual value. This is to determine if the linear combination will produce a stationary series. A null hypothesis of non-stationarity was tested against an alternative hypothesis. The optimal laG length was determined using both the Schwarz and the Akaike Information Criteria and was found to be zero. The EG test was performed both with trend and without trend. With a calculated ADF values of 5.6354 (without trend) and -5.5535 (with trend)

being significant at 1% (using the Mackinnon critical values), the null hypothesis was rejected confirming the existence of co-integration or a long run relationship. Thus, the residual was found to be stationary i.e. integrated of order zero;  $I(0)$ . This result shows that there is a tendency for the variables to converge to their long-run equilibrium after a shock.

Having established a co-integrating relationship among the variables, an error correction model (ECM) was specified as:

$$\Delta e_t = \vartheta_0 + \vartheta_1 \Delta p_t^d + \vartheta_2 \Delta p_t^f + \vartheta_3 d + \vartheta_4 ecmt_{t-1} + v_t \quad \dots\dots\dots 8$$

As shown in table 4, domestic price and foreign price levels, the dummy variable and the ECM are significant at 1%, while the constant term is not significant even at 10%. All variables are correctly signed. The positive sign on the dummy variable indicate that the structural change had a direct impact on exchange rate determination in Nigeria. With an adjusted  $R^2$  of 0.69 and F-statistics significant at 1%, the model performed well. The Durbin-Watson statistic standing at 1.76 shows that the error process is free of autocorrelation while the standard error of the regression derived as 0.16 implies a good fit of the data to the regression line.

Domestic and foreign price levels and the regime switch, therefore, exert significant influence on exchange rate. Contrary to the *a priori* expectation, however, domestic and foreign price levels do not maintain a one-to-one relationship. Though correctly signed, the coefficient of the CPI in Nigeria was approximately +1(as expected), while that of the USA was approximately 3 (as against the expected value of 1). This literarily means that goods are about three times more expensive in Nigeria than in the USA if converted using the naira-dollar exchange rate. The significance of the long-run component of equation 8, i.e. the ECM, showed that a long-run

<sup>1</sup> The residual series generated from the static regression.

<sup>2</sup> See appendix for details of the result.

relationship exists between the relevant price levels and the exchange rate, thereby confirming the validity of purchasing power parity in Nigeria. The co-efficient of the ECM standing at 0.94 indicates that about 0.94 of the disequilibrium (or deviation from long run relationship) is adjusted for in the short run i.e. within one year. In addition, the results show that short-run changes in domestic and foreign price levels have significant positive and negative effects on nominal exchange rate, respectively. It shows also that, deviations in the nominal exchange rate from its equilibrium level are corrected at rate of about 94% yearly.

Table 4

**Result of the Error Correction Model (Dummy inclusive)**

Dependent variable: Change in the log of nominal exchange rate

Sample: 1970 - 2003. 33 observations.

Variable	Coefficient	Std. Error	T-statistics	Prob
Constant	0.049821	0.045978	1.083583	0.2878
?log (CPI Nigeria)	1.168331	0.307707	3.796895	0.0007
?log (CPI USA)	-2.855703	0.753712	-3.788852	0.0007
Dummy	0.777017	0.034456	22.55124	0.0000
ECM (-1)	-0.937559	0.227458	-4.341723	0.0002
R-Squared	0.732408	Mean dependent var	0.157515	
Adjusted R <sup>2</sup>	0.694181	S.D. dependent var	0.297120	
S.E. of regression	0.164310	Akaike info criterion	-0.635398	
Sum squared residual	0.755936	Schwarz criterion	-0.408655	
Log likelihood	15.48407	F-statistic	19.15926	
Durbin-Watson stat	1.786611	Prob (F-statistic)	0.000000	

<sup>1</sup> The ECM is the residual series generated from the static equation, and is different from  $v$  in equation 8.



Having established the PPP, the importance of the different exchange rate regimes was investigated. Recall that a dummy variable was included in the estimation of the long-run static model. The dummy was removed and a new residual series was derived. This was applied on equation 8 (but without the dummy variable), giving a second error correction model. The differenced variables in the model were once again significant. An F-statistics significant at 5% portrayed a good fit for the model, though the adjusted  $R^2$  stood at 0.23. At 1.83, the Durbin-Watson test indicated no incidence of autocorrelation. The ECM was, however, not significant for the model, though, it bore the right sign (see table 5). This implies, therefore, that the second model is relevant only for short-run analysis.

Table 5

Result of the Error Correction Model (Dummy exclusive)

Dependent variable: Change in log of nominal exchange rate

Sample: 1970 - 2003. 33 observations.

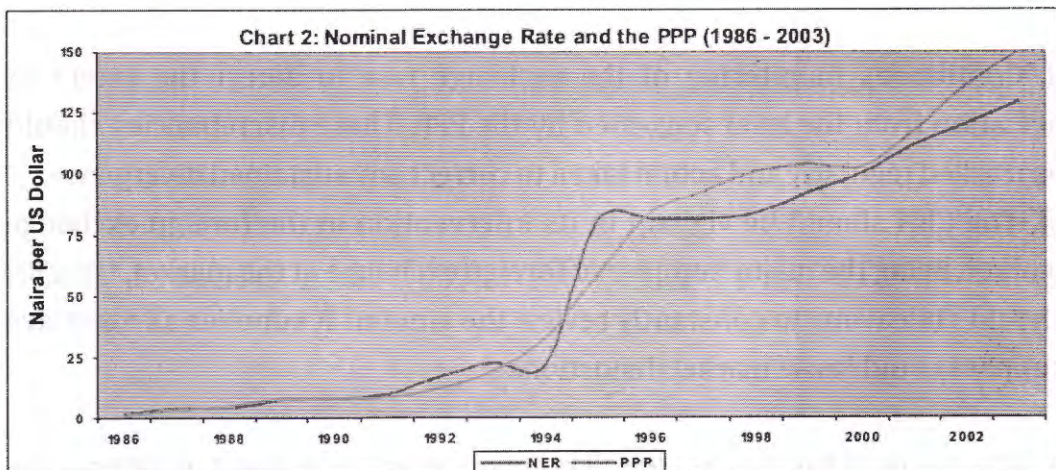
Variable	Coefficient	Std. Error	T-statistics	Prob
Constant	0.130537	0.114453	1.140525	0.2634
$\Delta \log$ (CPI Nigeria)	0.978087	0.356201	2.745880	0.0103
$\Delta \log$ (CPI USA)	-3.306374	1.629218	-2.029425	0.0517
ECM2 (-1)	-0.227022	0.137203	-1.654639	0.1088
R-Squared	0.300296	Mean dependent var	0.157515	
Adjusted $R^2$	0.227913	S.D. dependent var	0.297120	
S.E. of regression	0.261075	Akaike info criterion	0.265191	
Sum squared residual	1.976637	Schwarz criterion	0.446586	
Log likelihood	-0.375647	F-statistic	4.148699	
Durbin-Watson stat	1.829611	Prob (F-statistic)	0.014582	

<sup>1</sup>. The model estimated in the preliminary analysis. The residual of this model formed the ECM.

A comparative analysis of the two error correction models shows that the inclusion of a dummy variable is germane in the model. The dummy variable was used as a proxy for the exchange rate regimes in Nigeria. This implies that the different exchange rate systems are imperative in investigating PPP in Nigeria. More specifically, the result of ECM with the dummy showed that floating the exchange rate had a considerable effect in its re-alignment towards a long-run equilibrium level.

Table 6						
The Nominal Exchange Rate (NER) and Purchasing Power Parity (PPP)						
Year	NER	PPP		Year	NER	PPP
1970	0.7143	0.6035		1987	4.0179	3.3765
1971	0.6955	0.6831		1988	4.5367	5.2304
1972	0.6579	0.6689		1989	7.3916	7.8150
1973	0.6579	0.6039		1990	8.0378	7.7908
1974	0.6299	0.5393		1991	9.9095	8.2219
1975	0.6159	0.6261		1992	17.2984	12.0240
1976	0.6265	0.7122		1993	22.3268	19.7398
1977	0.6466	0.7768		1994	21.8861	32.8387
1978	0.6060	0.7650		1995	81.0228	60.4980
1979	0.5957	0.6694		1996	81.2528	81.1149
1980	0.5464	0.5537		1997	81.6494	86.5623
1981	0.6100	0.5602		1998	83.8072	94.0687
1982	0.6729	0.5451		1999	92.3428	96.9409
1983	0.7241	0.6588		2000	100.1194	96.9181
1984	0.7649	0.9007		2001	111.5166	111.9796
1985	0.8938	0.9016		2002	120.4700	127.1162
1986	2.0206	2.0206		2003	129.2230	141.4784

Given that the first error correction model (dummy inbedded) is significant, it can be indubitably said that considering the exchange rate policy switch, the PPP is applicable in Nigeria, using the nominal exchange rate. The naira per dollar exchange rate is tending towards its long-run equilibrium and will adjust to any shock at a speed of 97% yearly. The exchange rate, currently determined via a managed float, is still overvalued as suggested by the PPP in table 6 above. Efforts should, therefore, be geared towards ensuring that the exchange rate is left to the vagaries of the market forces.



## VI. Conclusion

This paper undertook an empirical examination of the long-run co-movement in the naira exchange rate and the relative price levels of Nigeria and USA. The impact of the policy swap from a system of exchange rate control to that determined by market forces was investigated. An error correction model was utilized in the analyses. The outcome revealed the validity of the PPP using Nigerian data. Thus, a long-run association is intrinsic in the exchange rate and the relevant price levels. The model also showed that the exchange rate would revert to its equilibrium position i.e. the PPP, after any upset. From the analysis it is apparent that the naira exchange rate is actually in close proximity to its PPP. It was also discovered that the change in exchange rate regimes had considerable



The objective of the study was to systematically analyze the causal relationship between income growth and child malnutrition using a multi-country data. It thus contributed to the growth and poverty reduction debate by shedding more light on the impact of income growth on child malnutrition and whether such growth is enough to ensure a drastic reduction of malnutrition rate in developing countries. The paper was divided into three sections excluding the introduction. Section I contained the data and model while section II examined the results from the household surveys and cross-country analysis. The paper was concluded in section III.

## I. Summary of the Paper

The study utilized two data sources: the household surveys and cross-country data. The household surveys were obtained from 12 countries to cover a range of locations, spanning four continents. The measure of nutritional status (N) used is weight for age, converted into standardized units called z-scores. The study referred to children with a weight-for-age z-score of less than 2 as underweight. The authors estimated regressions for nutritional outcomes as a function of the log of per capita household expenditures. Additional regressors used include education levels of the child's mother and father, six dummy variables for age brackets, indicators for the type of drinking water and toilet used, dummy variables for ethnic background (in some countries), the height of the mother (where available) and demographic variables such as household size and the percentage of household which lies in different age groups. The study undertook two specifications of the model. Model 1 included expenditures but excluded health, water and sanitation infrastructure both external and internal to the household. Model 2 however, controlled for the variables excluded in model 1. The authors considered model 1 as a better representation of the total effect of resources in a long-run scenario. The models were estimated using

both OLS and Instrumental Variables techniques.

The cross-country data set covered 61 developing economies, with each country having at least two observations and spanning the period 1970–1995. The dependent variable was the prevalence of children under age five who are underweight for their age. This is matched with the corresponding year's value of per capita GDP expressed in 1987 U.S. dollars adjusted for the Purchasing Power Parity (PPP) rates as the independent variable. Other explanatory variables included in the regression were female secondary school enrolment, access to safe water, and decade dummy variables.

The household survey results indicated that the log of per capita household consumption had a positive relationship with the nutritional status of children as measured by weight-for-age in all the countries studied. The authors found the mean coefficient to be 0.54 (using their preferred estimates of model 1) implying that doubling household income will increase weight-for-age by half a standard deviation from the median for the reference population. To directly infer the effect of income growth on malnutrition rates, the authors sought to simulate the expected proportional reduction in malnutrition after sustained per capita income growth of 2.5 per cent a year, using the coefficients in model 1. The results indicated that only in 3 of the 12 countries—Jamaica, Morocco and Peru—does per capita income growth of 2.5 per cent result in halving of the malnutrition rate by 2015. The relative decline ranged from 13 per cent in Romania to 63 per cent in Peru, averaging 34 per cent in all the 12 countries.

Results from the cross-country analysis indicated a negative and significant effect of per capita GDP on malnutrition rates. The negative signs of the decade dummy variables also indicated declines in malnutrition rates overtime. Simulation results based on the estimated coefficients on the log of per capita GDP from the OLS regression indicated that a 2.5 per cent

annual growth in per capita GDP between 1995 and 2015 would reduce the malnutrition rate by 8 percentage points, or 32 per cent of the initial rate, compared with the average relative decline of 34 per cent for the 12 countries surveyed. According to the authors, the results refuted a hypothesis that per capita GDP growth fails to improve the nutritional status of the most vulnerable.

The authors concluded, based on their findings that, sustained per capita income growth will go a long way toward halving child malnutrition rates by 2015. However, malnutrition would persist in the face of rapid income growth in the absence of additional measures to address malnutrition directly. Thus, direct and effective nutrition and health interventions that could accelerate reductions in malnutrition in the short-run are urgently needed. Some of these interventions, according to the authors, include vitamin A supplementation for children under age five, iron supplementation for pregnant women and some type of nutrition education and community-based behaviour change initiatives, even though some of these initiatives are more effective than others.

## I. Comments and Conclusion

The study is structurally worthwhile and commendable as it shed more light on what must be done to reduce child malnutrition in developing countries one of the objectives for the Millennium Development Goals for Poverty and Hunger. The strength of the paper lies in the simplicity of analysis using both micro studies and cross-country regressions. The need to ensure a rapid and sustained per capita income growth over the next one decade and adopt direct nutrition and health interventions to enable developing countries reduce the menace was vividly demonstrated.



The study, however, assumed a sustained per capita income growth of at least 2.5 per cent per annum in all developing countries between 1995 and 2015 as used in the simulation. While the figure may appear optimistic, past trends in economic growth and the present realities depicts that the rate may not be achieved by most of the developing countries, thus, making it difficult to meet the MDG target for poverty and hunger. This is in line with the fact that only 3 of the 12 countries involved in the household survey achieved this growth rate over the 1990s, while 5 countries recorded negative growth rates. To achieve the 2.5 per cent sustained growth, therefore, developing countries need to initiate policies that promote economic efficiency, and implement programmes that may ensure a rapid growth in their per capita incomes, which the authors were silent on. This may include promoting more and better productive investments and education, ensuring macroeconomic stability, trade liberalization, privatization, diversification, among others. Meanwhile, the paper assumed a broad-based economic growth across countries. Yet, growth can be associated with rising inequality, which then tends to offset part of the gains from growth for the poor. Given this, rapid growth may not necessarily entail poverty reduction and drastic reduction in the prevalence of malnutrition. It can only assure this, provided it is accompanied by policies to promote access to education, health and social services, and by the provision of safety nets especially during adjustment periods (World Bank 1990, World Development Report).

Overall, the paper is relevant to Nigeria because both the micro studies and the cross-country regressions utilized data mostly from developing economies even though they differ appreciably in their economic situations. It shows clearly that to reduce poverty and hunger in the country, efforts must be made to formulate policies that would ensure a rapid and sustained per capita income growth that is seen to be pro-poor. The adoption of the new economic reform programme the National Economic Empowerment

and Development Strategy (NEEDS), which is focused mainly on wealth creation, employment generation, poverty reduction, corruption elimination and value re-orientation, and has four key pillars reforming government and its institutions, growing the private sector, implementing a social charter and reorienting the people with an enduring African value system - is a step in the right direction. In addition, the government may need to restore budgetary priority to agriculture as the engine of economic empowerment for the enhancement of human capacity in all sectors concerned with hunger reduction in Nigeria. The government should also implement and prioritize programmes that will improve the nutritional status of vulnerable groups as well as improving market functions in ways that will create synergies and result in positive transformations. Finally, the government should implement policies that would gradually increase the productivity of small-scale farms in less-favoured areas to enable the farmers increase yields of staple crops as well as generate marketable surpluses.